



Attorney Docket No. 12843US02

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

PATENT APPLICATION OF:	)	
	)	
GREGORY JAMES and	)	Group Art Unit 1745
RAJEEV VOHRA	)	
	)	Examiner C. Chaney
SERIAL NO. 09/998,531	)	
	)	
FILED: NOVEMBER 29, 2001	)	
	)	
FOR: METHOD AND APPARATUS FOR	)	
OPERATING AN	)	
ELECTROCHEMICAL FUEL CELL	)	

**DECLARATION OF DAVID WAINWRIGHT**  
**UNDER 37 C.F.R. §1.131**

Commissioner for Patents  
P.O. Box 1450  
Alexandria, VA 22313-1450

Sir:

I, David Wainwright, declare as follows:

1. I am employed as a patent agent in the Intellectual Property Group of Ballard Power Systems Inc. of Burnaby, Canada, which is the assignee of the above-identified application, Serial No. 09/998,531.

2. Exhibit A hereto is a copy of Ballard Invention Memo No. 300, which I received on July 12, 2000, from Gregory James, the

first-named inventor of the above-identified application, Serial No. 09/998,531.

3. In accordance with my normal practice in receiving Invention Memos from Ballard inventors, I signed Ballard Invention Memo No. 300 as a witness on the day I received it, namely, July 12, 2000.

\* \* \* \* \*

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under §1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application and any patent issued thereon.

Date: December 17, 2003

David Wainwright  
David Wainwright



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**DECLARATION OF GREGORY JAMES  
UNDER 37 C.F.R. §1.131**

Commissioner for Patents  
P.O. Box 1450  
Alexandria, VA 22313-1450

Sir:

I, Gregory James, declare as follows:

1. I am an employee of Ballard Power Systems Inc. of Burnaby, Canada, which is the assignee of the above-identified application, Serial No. 09/998,531.

2. I am the first-named inventor of the subject matter claimed in the above-identified application, Serial No. 09/998,531.

3. I have been informed that McElroy U.S. Patent No. 6,589,678, which issued on July 8, 2003 and was filed on September 28, 2000, has been cited as a prior art reference against the present application.


4. Exhibit A hereto is a copy of Ballard Invention Memo No. 300, which I prepared and transmitted to David Wainwright, a patent agent in Ballard's Intellectual Property Group, and which, upon information and belief, Mr. Wainwright signed as a witness on July 12, 2000. Item 4 of Ballard Invention Memo No. 300 discloses the concept of operating a fuel cell supplied with a fluid stream, the fuel cell having a mean life expectancy, in which the method of operation comprises reversing the direction of flow of the fluid stream after a time period of operation of the fuel cell. All of the pages of Exhibit A were written and based upon work that I and my co-inventor, Rajeev Vohra, performed prior to September 28, 2000, which is the filing date of McElroy U.S. Patent No. 6,589,678.

5. I and my co-inventors invented the claimed subject matter prior to September 28, 2000, which is the filing date of McElroy U.S. Patent No. 6,589,678.

\* \* \* \* \*

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under §1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application and any patent issued thereon.

Date: 17 - Dec - 03

  
\_\_\_\_\_  
Gregory James

- ☒ Ballard Power Systems  
☐ Ballard Advanced Materials  
☐ Ballard Power Corporation  
☐ Ballard Generation Systems

Disclosure Number <b>300</b>	Title of Idea Maintenance strategy to prolong fuel cell life
Originator(s) Greg James	
Which group(s) are the originals working in? UCE Reliability	
First Drawing(s) dated no later than:	Notebook & Page Numbers
First written description dated no later than: October 4th, 1999	Notebook & Page Numbers Stationary Stage Gate Review (MAG#1)
First disclosed by the inventor(s) to another person (specify who) no later than: September 20th, Greg Knowles, Rob Esterer	
Memo Written by Greg James	Date July 10th, 2000
First Working Prototype Completed no later than:	
<b>1. What is the technical field of the invention?</b> Design of an electrochemical fuel cell stack to increase the Mean Time to Failure by the switching of the gas and coolant inlets and outlets after a specified time period to ultimately extend the life of the stack.	
<b>2. What problem were you trying to solve or what need were you trying to fulfill when you developed this idea?</b> The above idea has been developed to help increase the durability and ultimately the reliability of the fuel cell stack in any application using a fuel cell stack.	
<b>3a. How have we at Ballard and others tried to solve this problem in the past?</b> This problem has always been attacked by trying to increase the durability of the individual components that make up the stack including the unit cell component. These attempts which have had success include material changes and/or design changes.	
<b>3b. How has the prior solution failed to completely solve the problem or address the need?</b> The prior solutions have had success in the past, however, components in the stack, especially the unit cell components, have failed quicker either near the inlets or outlets depending on the conditions the stack was operated under. Currently we do not have the experience or know how to solve some problems at the problem areas. Furthermore, any solution to solve the problem at these discrete areas may be unacceptably expensive or unmanufacturable.	
<b>4. Summarize each of your invention(s) in 25 words or less (think about what is new in your approach):</b> Design of an electrochemical fuel cell stack to increase the Mean Time to Failure by the switching of the gas and coolant inlets and outlets after a specified time period to ultimately extend the life of the stack.	
<b>5a. Describe the invention in more detail and explain how it works. Attach drawings or diagrams, and referring to them describe each component of the invention and how the components interact to solve the problem:</b>	

Can increase the MTBF with minimal cost (i.e. greatly reduce life cycle costs)  
Decrease the degradation rate of the stack to allow longer operation.  
Invention can increase the durability of a number of parts with one operation

9. Describe any alternative uses of the invention you can envisage:

This invention can be used as part of a overall maintenance plan. For example, while the stacks are being rotated, they can be leak checked, and inspected for damage.

10. Identify (source, patent number, reference, etc.) any prior publications or disclosures you are aware of which may be relevant. Attach documentation if available.

11. If the invention has been a) published, b) commercially used, c) disclosed to third parties, d) offered for sale, or e) sold, explain below:

12. Are any of the originators employed under a German employment contract? If yes, who?

Signed (Inventor)	Date
Signed (Inventor)	Date
Signed (Inventor)	Date
Reviewed by manager(s) - Signed	Date
For Completion by I.P. Group	
On the date opposite my signature below, I read and understood this disclosure ( <u>3</u> pages in total, including <u>0</u> attached pages of drawings, plots, etc.)	
Signed (Witness from IP Group) <i>David Wainwright</i>	Date <i>July 17, 2000</i>

Due to the electrochemistry of the fuel cell, the conditions at the inlet of the stack are quite different than at the outlet of the stack. These differences include gas composition, gas pressure, gas velocity, gas relative humidity, gas & coolant temperatures, and MEA contamination. The known failure mechanisms occur primarily in either the inlet or outlet regions of the stack, however, the failure mechanisms can be different from inlet to outlet. Both inlet and outlet failure cause the stack to be taken out of service and either scrapped or refurbished.

By designing the stack to have the inlets and outlets to the stack to be symmetric, the inlets and outlets can be reversed at 90% of the MTBF. Therefore, the failure location causing end of life (EOL) would be operated under a more benign conditions, thus extending the useful life of the stack.

Practical examples are as follows:

Stationary program has stack life limited by membrane thinning at a faster rate in the fuel inlet compared to rest of MEA. This failure under high loaded MEAs occurs at 6500 hours. By rotating the quadrants 180 at 5000 hours, the fuel inlet will become the fuel outlet which will slow the thinning process and allow the stack to operate past 6500 hours.

In any of the long life programs (greater than 5,000 hours), contamination will start causing voltage degradation. The contamination will build up in the first part of the MEA where a majority of the reaction is occurring. By switching the inlets and outlets, the most contaminated part of the MEA will be furthest away from the high reaction area, thus helping to reduce the degradation rate.

It has been established that a greater portion of the reaction is happening in the first section of the MEA. This will cause the material degradation of the components in this area to happen quicker. By switching the inlet and outlets of the stack, the material average becomes averaged out, which will allow the stack to operate longer.

5b. Describe possible modifications or alternative versions of the invention, and comment on which version is preferred and why:

6. Describe the structural and/or functional differences between your solution and the prior solution(s):

Prior solutions to increase the MTBF have focused on solving specific failures. This invention extends the life of the stack by changing the conditions causing the material degradation leading to failure at some time before the failure. Furthermore, this invention is easy to put into a maintenance cycle that can be done at a regular interval. This idea is similar to the preventative maintenance idea behind changing a vehicle's timing belt after 100,000 kms of operation.

7. Describe the results achieved by your solution. Attach data and graphs to illustrate any results you have obtained:

A 4-Cell P2B test was conducted to determine the effect of 5 PPM ammonia on stack performance over time. After 2,300 hours of operation the stack had lost approximately 50 millivolts per cell. At this time, the stack was rotated (i.e. inlet of the stack rotated to the outlet) and restarted approximately 40-50 millivolts higher and maintained this voltage. Before the stack rotation, the ammonia was contaminating the inlet area of the stack where a high proportion of the reaction occurs. However, the outlet would not have seen a lot of ammonia as it is filtered out in the inlet area. By rotating the outlet of the stack making it the inlet of the stack, the fuel cell reaction can occur without being inhibited by the ammonia. Formal test report will be released in 2-3 weeks.

8. List all the advantages of your solution you can think of, even those not directly related to the problem: